NEUROTRANSMITTERS

- Neurotransmitters are substances which neurons use to communicate with one another and with their target tissues in the process of synaptic transmission (neurotransmission).
- Neurotransmitters are synthetized in and released from nerve endings into the synaptic cleft. From there, neurotransmitters bind to receptor proteins in the cellular membrane of the target tissue. The target tissue gets excited, inhibited, or functionally modified in some other way.
- There are more than 40 neurotransmitters in the human nervous system; some of the most important are acetylcholine, norepinephrine, dopamine, gamma-aminobutyric acid (GABA), glutamate, serotonin, and histamine.

Excitatory neurotransmitters

Excitatory neurotransmitters function to activate receptors on the postsynaptic membrane and enhance the effects of the action potential, while inhibitory neurotransmitters function to prevent an action potential. In addition to the above classification, neurotransmitters can also be classified based on their chemical structure:

Amino acids – GABA, glutamate

Monoamines – serotonin, histamine

Catecholamine (subcategory of monoamines) – dopamine, norepinephrine, epinephrine

Acetylcholine

- Acetylcholine (ACh) is an excitatory neurotransmitter secreted by motor neurons that innervate muscle cells, basal ganglia, preganglionic neurons of the autonomic nervous system, and postganglionic neurons of the parasympathetic and sympathetic nervous systems.

Type: Excitatory in all cases except in the heart (inhibitory)

Released from: Motor neurons, basal ganglia, preganglionic neurons of the autonomic nervous system, postganglionic neurons of the parasympathetic nervous system, and postganglionic neurons of the sympathetic nervous system that innervate the sweat glands

Functions: Regulates the sleep cycle, essential for muscle functioning

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- Its main function is to stimulate muscle contraction. However, the only exception to this, where acetylcholine is an inhibitory neurotransmitter, is at the parasympathetic endings of the vagus nerve.
- These inhibit the heart muscle through the cardiac plexus.
- It is also found in sensory neurons and in the autonomic nervous system, and has a part in scheduling the "dream state" while an individual is fast asleep.
- Acetylcholine plays a vital role in the normal functioning of muscles. For example, poisonous plants like curare and hemlock cause paralysis of muscles by blocking the acetylcholine receptor sites of myocytes (muscle cells). The well-known poison botulin works by preventing vesicles in the terminal bouton from releasing acetylcholine, thus leading to paralysis of the effector muscle.

Norepinephrine

Norepinephrine (NE), also known as noradrenaline (NAd), is an excitatory neurotransmitter produced by the brainstem, hypothalamus, and adrenal glands and released into the bloodstream. In the brain it increases the level of alertness and wakefulness.

Type: Excitatory

Released from: Brainstem, hypothalamus, and adrenal glands

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Functions:

- Increases the level of alertness and wakefulness, stimulates various processes of the body
- In the body, it is secreted by most postganglionic sympathetic nerves.
- It acts to stimulate the processes in the body. For example, it is very important in the endogenous production of epinephrine. Norepinephrine has been implicated in mood disorders such as depression and anxiety, in which case its concentration in the body is abnormally low. Alternatively, an abnormally high concentration of it may lead to an impaired sleep cycle.

Epinephrine

- Also known as adrenaline (Ad), epinephrine (Epi) is an excitatory neurotransmitter produced by the chromaffin cells of the adrenal gland. It prepares the body for the fight-or-flight response. That means that when a person is highly stimulated (fear, anger etc.), extra amounts of epinephrine are released into the bloodstream.

Type: Excitatory

Released from: Chromaffin cells of the medulla of adrenal gland

Functions:

- The fight-or-flight response (increased heart rate, blood pressure, and glucose production)
- This release of epinephrine increases heart rate, blood pressure, and glucose production from the liver (glycogenolysis). In this way, the nervous and endocrine systems prepare the body for dangerous and extreme situations by increasing nutrient supply to key tissues.

Dopamine

- Dopamine (DA) is a neurotransmitter secreted by the neurons of the substantia nigra. It is considered a special type of neurotransmitter because its effects are both excitatory and inhibitory. Which effect depends on the type of receptor that dopamine binds to.

Type: Both excitatory and inhibitory

Released from: Substantia nigra

Functions:

- Inhibits unnecessary movements, inhibits the release of prolactin, and stimulates the secretion of growth hormone .As a part of the extrapyramidal motor system which involves the basal ganglia, dopamine is important for movement coordination by inhibiting unnecessary movements. In the pituitary gland, it inhibits the release of prolactin, and stimulates the secretion of growth hormone.
- Dopamine deficiency related to the destruction of the substantia nigra leads to Parkinson's disease. Increased activity of dopaminergic neurons contributes to the pathophysiology of psychotic disorders and schizophrenia. Drug and alcohol abuse can temporarily increase dopamine levels in the blood, leading to confusion and the inability to focus. However, an appropriate secretion of dopamine in the bloodstream plays a role in the motivation or desire to complete a task.

GABA

- Gamma-Aminobutyric acid (GABA) is the most powerful inhibitory neurotransmitter produced by the neurons of the spinal cord, cerebellum, basal ganglia, and many areas of the cerebral cortex. It is derived from glutamate.

Type: Inhibitory

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Released from: Neurons of the spinal cord, cerebellum, basal ganglia, and many areas of the cerebral cortex

Functions:

- Reduces neuronal excitability throughout the nervous system
- Functions of GABA are closely related to mood and emotions.
- It is an inhibitory neurotransmitter that acts as a brake to excitatory neurotransmitters; thus when it is abnormally low this can lead to anxiety.
- It is widely distributed in the brain and plays a principal role in reducing neuronal excitability throughout the nervous system.

Glutamate

- Glutamate (Glu) is the most powerful excitatory neurotransmitter of the central nervous system which ensures homeostasis with the effects of GABA. It is secreted by neurons of the many of the sensory pathways entering the central nervous system, as well as the cerebral cortex.

Type: Excitatory

Released from: Sensory neurons and cerebral cortex

Functions:

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- Regulates central nervous system excitability, learning process, memory
- Glutamate is the most common neurotransmitter in the central nervous system; it takes part in the regulation of general excitability of the central nervous system, learning processes, and memory. Thus, inappropriate glutamate neurotransmission contributes to developing epilepsy and cognitive and affective disorders.

Serotonin

- Serotonin (5-hydroxytryptamine, 5-HT) is an inhibitory neurotransmitter that has been found to be intimately involved in emotion and mood. It is secreted by the neurons of the brainstem and by neurons that innervate the gastrointestinal tract (enteric nervous system). In addition, serotonin is found in platelets (thrombocytes) which release it during coagulation (hemostasis).

Type: Inhibitory

Released from: Neurons of the brainstem and gastrointestinal tract, thrombocytes

Functions;

- Regulates body temperature, perception of pain, emotions, and sleep cycle

- In participates in regulation of body temperature, perception of pain, emotions, and sleep cycle. An insufficient secretion of serotonin may result in decreased immune system function, as well as a range of emotional disorders like depression, anger control problems, obsessive-compulsive disorder, and even suicidal tendencies.

Histamine

- Histamine is an excitatory neurotransmitter produced by neurons of the hypothalamus, cells of the stomach mucosa, mast cells, and basophils in the blood. In the central nervous system, it is important for wakefulness, blood pressure, pain, and sexual behavior. In the stomach, it increases the acidity.

Type: Excitatory

Released from: Hypothalamus, cells of the stomach mucosa, mast cells, and basophils in the blood

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Functions:

- Regulates wakefulness, blood pressure, pain, and sexual behavior; increases the acidity of the stomach; mediates inflammatory reactions
- It is involved primarily in the inflammatory response, as well as a range of other functions such as vasodilation and regulation of the immune response to foreign bodies. For example, when allergens are introduced into the bloodstream, histamine assists in the fight against these microorganisms causing itching of the skin or irritations of the throat, nose, and or lungs.

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